CLAIMS

1. An apparatus for depositing ionized molecules onto a target surface of an object in a vacuum system, the apparatus comprising:

an ion deposition system for depositing the ionized molecules onto the target surface;

a plasma treatment system for plasma-treating the target surface; and

a target guiding system to guide the target surface within the vacuum.

2. The apparatus of claim 1, further comprising an ionized molecule source.

3. The apparatus of claim 2 wherein the ionized molecule source comprises at least a selected one of the following: an electrospray ionization source; an Atmospheric Pressure Chemical Ionization (APCI) source; a Fast-Atom Bombardment (FAB) source; a Liquid Secondary Ion Mass Spectrometry (LSIMS) source; a Continuous FAB source; or a Matrix-Assisted Laser Desorption Ionization (MALDI) source.

4. The apparatus of claim 1 wherein the ion deposition system is configured to deposit ionized biomolecules.

5. The apparatus of claim 1 wherein the ion deposition system is configured to deposit ionized enzymes.

6. The apparatus of claim 1 wherein the ion deposition system is configured to deposit ionized hyaluronic acid.

7. The apparatus of claim 1 wherein the ion deposition system is configured to deposit ionized sugars.

8. The apparatus of claim 1 wherein the ion deposition system is configured to deposit ionized molecules onto a stainless steel surface.

9. The apparatus of claim 1 wherein the ion deposition system is configured to deposit ionized molecules onto a surface of polymeric material.

10. The apparatus of claim 1 wherein the ion deposition system comprises an ion optics system.

11. The apparatus of claim 1 wherein the ion deposition system comprises an ion funnel.

12. The apparatus of claim 1 wherein the ion deposition system comprises a multipole ion guide.

13. The apparatus of claim 1 wherein the target guiding system comprises a connection for applying a biasing voltage to the target surface.

14. The apparatus of claim 1 wherein the plasma treatment system comprises a radio frequency plasma generator.

15. The apparatus of claim 1 wherein the plasma treatment system comprises an audio frequency plasma generator.

16. The apparatus of claim 1 wherein the plasma treatment system comprises a microwave plasma generator.

17. The apparatus of claim 1 wherein the plasma treatment system comprises a direct current plasma generator.

18. The apparatus of claim 1 wherein the plasma treatment system comprises:

a gas introduction system having mass flow controllers;

a reaction chamber;

a plasma generator; and

a pumping system.

19. The apparatus of claim 18 wherein the pumping system comprises a contamination trap, a throttle value, vacuum gauges, and a feedback control.

20. The apparatus of claim 1 wherein the target guiding system comprises a positioning member, the positioning member being operable to position the target surface within the apparatus.

21. The apparatus of claim 1 wherein the target guiding system is configured to move and thereby position the target surface within the plasma treatment system and within the ion deposition system.

22. The apparatus of claim 1 wherein the ion deposition system comprises:

an ion funnel;

a pump;

a multipole ion guide;

ion current sensors; and

a deposition chamber.

23. An apparatus for depositing ionized molecules on a target surface, the apparatus comprising:

a deposition chamber in a vacuum system;

an electrospray injector to generate ionized molecules and inject them into the vacuum system;

an ion optics system in the vacuum system to guide ionized molecules to the deposition chamber;

a plasma reactor in the vacuum system to treat the target surface; and

a target surface transfer system to position the target surface within the apparatus.

24. The apparatus of claim 23 wherein the electrospray injector comprises:

a syringe pump to pump molecules;

a spray capillary connected to the syringe pump to spray pumped molecules;

a high voltage power supply system to maintain a bias voltage on the spray capillary with respect to a bias voltage on the ion optics system and to ionize sprayed molecules; and

a drying gas source to provide drying gas;

wherein the spray capillary and the ion optics system are positioned so that drying gas and ionized molecules are propelled into the vacuum system via the ion optics system.

25. The apparatus of claim 24 wherein the spray capillary is mounted on a multi-coordinate manipulator to manipulate the position of the spray capillary with respect to the ion optics system.

26. The apparatus of claim 24 wherein the ion optics system has an inlet capillary mounted in a mounting block comprising a heater and thermocouple and the drying gas flows past the heater and in the opposite direction to the spray from the spray capillary.

27. The apparatus of claim 23 wherein the ion optics system comprises:

an ion funnel having an axis; and

a multipole ion guide having an axis;

wherein the ion funnel is biased with a DC potential gradient to propel ionized molecules through the ion funnel, a RF voltage is applied to the ion funnel to move ion molecules toward the axis of the

ion funnel, and the multipole ion guide is positioned to receive ionized molecules from the ion funnel.

28. The apparatus of claim 27 wherein the ion optics system further comprises a pump, wherein the electrospray injector injects a solvent as well as ionized molecules into the vacuum system and the pump removes solvents from the vacuum system.

29. The apparatus of claim 27 further comprising an aperture having an axis and positioned between the ion funnel and the multipole ion guide.

30. The apparatus of claim 29 wherein a bias voltage is applied to the aperture.

31. The apparatus of claim 29 wherein the axes of the ion funnel, the multipole ion guide and the aperture are aligned.

32. The apparatus of claim 27 wherein the multipole ion guide is controlled by a RF voltage.

33. The apparatus of claim 27 wherein the multipole ion guide is controlled by a DC bias voltage.

34. The apparatus of claim 27 wherein the multipole ion guide is an octapole ion guide.

35. The apparatus of claim 23 wherein the plasma reactor comprises:

a chamber having a gas inlet at one end and a vacuum pump at an opposite end;

a mass flow controller to control a gas flow through the gas inlet;

a pressure regulation system; and

a plasma generator.

36. The apparatus of claim 35 wherein the plasma generator comprises a plurality of electrodes in the reactor.

37. The apparatus of claim 35 wherein the pressure regulation system comprises a capacitance manometer and a throttle valve.

38. The apparatus of claim 23 wherein the target surface transfer system comprises a positioning member operable to position the target surface within the apparatus.

39. The apparatus of claim 23 wherein the target surface transfer system comprises an electrical coupling to the target surface.

40. The apparatus of claim 38 wherein the positioning member is biased with a bias voltage.

41. The apparatus of claim 23 further comprising a gate between the plasma reactor and the deposition chamber, and a gate valve to open and close the gate.

42. A method of depositing ionized molecules on a surface of an object in a vacuum system, the method comprising:

plasma-treating the surface of the object in the vacuum system; and

depositing ionized molecules on the surface of the object in the vacuum system.

43. The method of claim 42 wherein the surface of the object is plasma-treated prior to depositing ionized molecules on the surface of the object.

44. The method of claim 42 wherein ionized molecules are deposited on the surface of the object prior to plasma-treatment of the object.

45. The method of claim 42 further comprising generating ionized molecules by at least one the following methods: electrospray ionization; Atmospheric Pressure Chemical Ionization (APCI); Fast-Atom Bombardment (FAB); Liquid Secondary Ion Mass Spectrometry (LSIMS); Continuous FAB; and Matrix-Assisted Laser Desorption Ionization (MALDI).

46. The method of claim 42 wherein depositing ionized molecules comprises: introducing ionized molecules into the vacuum system; and guiding ionized molecules to the surface of the object.

47. The method of claim 46 wherein guiding ionized molecules comprises funneling ionized molecules using an ion funnel.

48. The method of claim 46 wherein guiding ionized molecules includes using multipole ion optics.

49. The method of claim 42, further comprising separating solvents from ionized molecules.

50. The method of claim 42, further comprising separating dry gas from ionized molecules.

51. The method of claim 42, further comprising measuring an ion current.

52. The method of claim 42, further comprising controlling an ion kinetic energy level of ionized molecules.

53. The method of claim 52 wherein the kinetic energy level is controlled by adjusting an electrostatic potential of the surface.

54. The method of claim 42, further comprising heating the surface of the object.

55. The method of claim 42, further comprising exposing the surface of the object to ultraviolet activation.

56. The method of claim 42, further comprising positioning the surface of the object to facilitate plasma-treatment and depositing of ionized molecules.

57. The method of claim 42 wherein the plasma-treatment comprises at least one of the following: plasma etching of the surface; opening of micropores of the surface; micro-roughening of the surface; coating the surface with polymeric substances; and plasma cleaning of the surface.

58. The method of claim 42 wherein the plasma-treatment produces dangling bonds on the surface.

59. The method of claim 42 wherein the plasma-treatment comprises substitution of chemical groups on the surface.

60. The method of claim 42 wherein the plasma-treatment comprises addition of chemical groups onto the surface.

61. The method of claim 42 wherein the plasma-treatment comprises treatment with at least one of the following as a process gas: O_2, N_2, N_2O, He, Ar, NH_3, CO_2, CF_4 and air.

62. The method of claim 42, further comprising controlling the plasma treatment by adjusting a power input to a plasma-generator.

63. The method of claim 42, further comprising controlling the plasma treatment by adjusting a gas-flow rate to a plasma-generator.

64. The method of claim 42, further comprising controlling the plasma treatment by changing a type of gas feed to a plasma-generator.

65. The method of claim 42 wherein the object is irregularly shaped.

66. The method of claim 42 wherein the surface on which ionized molecules are deposited is a stainless steel surface.

67. The method of claim 42 wherein the surface on which ionized molecules are deposited is a surface of polymeric material.

68. The method of claim 46 wherein guiding of ionized molecules comprises generating potential fields.

69. The method of claim 42 wherein the ionized molecules comprise biomolecules.

70. The method of claim 42 wherein the ionized molecules comprise enzymes.

71. The method of claim 42 wherein the ionized molecules comprise hyaluronic acid.

72. The method of claim 42 wherein the ionized molecules comprise sugar.

73. The method of claim 42 wherein the object is a medical device.

74. A medical device produced using the method of claim 42.

75. The method of claim 42, further comprising manipulating the object to deposit ionized molecules on an additional surface of the object.

76. The method of claim 75 wherein ionized molecules are deposited on the object in a pattern.

77. The method of claim 46 wherein guiding ionized molecules comprises using an electrostatic lens.

78. The method of claim 42, further comprising manipulating the object through an air-to-vacuum-to-air differentially pumped interface.

79. The method of claim 46 wherein guiding ionized molecules comprises generating a magnetic field.

80. The method of claim 46 wherein guiding ionized molecules comprises using an aperture.

81. The method of claim 42 wherein the object is a long, thin object.

82. An object having a surface coated with molecules applied using the method of claim 42.

83. An object having a surface coated with hyaluronic acid applied using the method of claim 42.

84. The method of claim 42 wherein the plasma treatment comprises coating the surface with a polymeric substance of a controlled molecular weight.

85. The method of claim 42 wherein the plasma treatment comprises coating the surface with a polymeric substance of a controlled chemical polarity.